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ABSTRACT

This monograph reports on the Planning Meeting of the Commonwealth Project on Improving the Quality of Science and Mathematics Education at the Basic Level which focused on the role of higher education. The purpose of the meeting was to make recommendations for improving the preparation and training of science and mathematics teachers for the first 9 years of education and of trainers of science and mathematics teachers. The report summarizes the meeting discussions on the following topics: curriculum and curriculum change; the education of teachers; inservice education of teachers (INSET); problems in teaching and teacher education; improving the education of teachers and teacher educators; proposals for gathering and disseminating information about INSET programs; and a strategy and action plan for developing INSET guidelines. Brief descriptions of several INSET programs are included. Four recommendations resulted from the meeting: (1) policies on education and professional development of teacher educators should be reviewed; (2) the proposed programs of overlapping and sustained INSET for teachers and teacher educators should be implemented; (3) steps should be taken to identify key personnel to take part in such INSET programs at all levels; and (4) national committees on basic science and mathematics teaching should be established to collect and review existing INSET materials and to prepare for regional and local workshops and INSET programs. Appendices include a list of consultants at the meeting, a list of documents prepared for the meeting, and draft suggestions for content guidelines. (Contains 11 references.) (ND)

ED 389 686

Quality in
Basic Education
Science, Technology and Mathematics

Improving the Quality of Science and Mathematics Education — The Role of Higher Education

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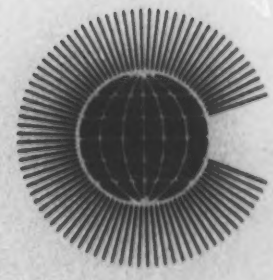

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IMPROVING THE QUALITY OF SCIENCE AND MATHEMATICS EDUCATION

The Role of Higher Education

Mary Harris

Commonwealth Secretariat

1993

COMMONWEALTH SECRETARIAT

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Project on Improving the Quality of Science and Mathematics at the Basic Level: The Role of Higher Education

Report on a Planning Meeting 26-29th May 1992

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Project on Improving the Quality of Science and Mathematics at the Basic Level: The Role of Higher Education

Report on a Planning Meeting 26-29th May 1992

Abstract and Summary

Content of Report

The Meeting:
1. reviewed teaching and teacher education in basic level science and mathematics and identified problems
2. reviewed personnel and practices in teacher education and identified problems,
3. proposed a structure for continuing, school-focussed and inter-related in-service education (INSET) for teachers and teacher educators involving the concept of key teachers and a cascade strategy,
4. proposed an action plan for putting a structure of INSET into practice.

Tasks presented to the meeting and responses to them:
Task a. to make suggestions on how to evolve and sustain innovative practices in the training of primary school teachers of science and mathematics
Response. The Meeting suggested closer involvement with schools as part of a continuum of co-operative INSET, building on good practice and continuing throughout a teacher's career. Criteria for developing such INSET were discussed and a cascade strategy involving key teachers is described.

Task b. to make recommendations on various types of innovative training activities for trainers of primary school teachers of science and mathematics.
Response. The meeting proposed the setting up of INSET programmes for teacher educators, to be closely related to the work of primary schools and the continuum of INSET for teachers. A structure for identifying and building on innovative activities is included in the proposed INSET programmes.

Task c. to plan a series of regional and national activities for serving primary school teachers of science and mathematics in which the consultants could act as leaders or co-ordinators.
Response. An action plan for a series of workshops is offered.

Task d. to recommend strategies for collaboration and funding of regional or national activities for serving primary school teachers and trainers of trainers in colleges of education.
Response. Strategies for collaboration are included in the action plan. The meeting recommended that the Commonwealth Secretariat prepare a document of up-to-date information on collaborative funding possibilities.

Task e. to propose items to be included in workshop training manuals for the efficient teaching of mathematics and science.

Response. The meeting recommended that an initial draft for such manuals should be prepared at or under the auspices of the Commonwealth Secretariat in the form of guidelines, but that detailed modification and particular content would need to be provided in the local context. A preliminary draft list of suggested items is offered in Appendix III of this report.

The Meeting made the following recommendations:

1. That policies on the education and professional development of teacher educators be reviewed with the aim of upgrading and supporting the development of the profession of teacher educator.

2. That the proposed programmes of overlapping and sustained INSET for teachers and teacher educators be set up as suggested.

3. That steps are taken to identify key personnel to take part in such INSET programmes at all levels.

4. That national committees on basic science and mathematics teaching should be set up to:
- collect and review existing INSET materials
- prepare for regional and local workshops and INSET programmes.

Introduction

1. The quality of basic science and mathematics education was a major topic of concern among the Commonwealth Ministers of Education at their conference in Barbados in 1990. The major determinant of quality in education is the teachers: therefore the quality of the education of teachers is crucial.

2. As a result of the Ministers' concern, the **Project on Improving the Quality of Science and Mathematics Education at the Basic Level: The Role of Higher Education** was set up by the Education Programme of the Commonwealth Secretariat. .

3. The Project was discussed at a planning meeting of consultants held in Hertford, UK, from 26 -29 May 1992. Consultants invited to the Meeting by the Commonwealth Secretariat and whose names are listed in Appendix I include:
- specialists within the fields of science and mathematics education at the Universities of Ibadan, Waikato, West Indies and Zimbabwe and in UNESCO:
- the Senior Education Officer (Science) in Botswana:
- independent consultants in mathematics and science education:
- the science advisor of the British Council Education Department.

4. The tasks presented to the Meeting were:

a. to make suggestions on how to evolve and sustain innovative practices in the training of primary school teachers of science and mathematics;

b. to make recommendations on various types of innovative training activities for trainers of primary school teachers in the specific areas of science and mathematics;

c. to plan a series of regional or national activities for serving primary school teachers of science and mathematics in which the consultants could act as leaders or co-ordinators;

d. to recommend strategies for collaboration and funding of regional or national activities for
   - serving primary school teachers
   - trainers of trainers in Colleges of Education

e. to propose items to be included in workshop training manuals for the efficient teaching of mathematics and science.

5. A number of relevant papers were presented by the Commonwealth Secretariat prior to the meeting. Case study reports were specially prepared by the consultants from Botswana, New Zealand, Nigeria, Trinidad and Tobago and Zimbabwe, with summary case studies from Asia and the Pacific. It is intended that these papers be published separately. The titles of all the papers are listed in Appendix II.

Definitions

6. For the purposes of the Project, 'basic' education is defined as the first nine years of schooling after attaining the approved starting age for universal primary education. Although the Project's focus is on primary education, in

many Commonwealth countries basic education as defined takes place in both primary and junior secondary schools.

7. The term 'higher' education usually applies to the degree-awarding institutions, that is to universities and polytechnics. In the context of this report, higher education includes colleges of education (see paragraph 13 below) and any post school education that is concerned with the education of teachers.

8. The Meeting viewed teaching as a profession and learning as a continuous process. When discussing the professional development of teachers, therefore, it is more appropriate to refer to teacher education than teacher training and the term 'teacher education' will be used in this report except in the case of quotations.

Discussion

9. The discussion was supported by the Case study reports (see paragraph 5 above) which will be published separately. The titles of the reports are listed in Appendix II.

Curriculum and Curriculum change

10. Initiatives to improve the quality of basic science and mathematics education in Commonwealth countries have included programmes to improve teaching, programmes of curriculum change and combinations of both. The general aims of the improvements have been to encourage children to think scientifically and mathematically, to learn how to learn, to take responsibility for their learning and thus derive confidence in their own ability to pursue, understand and apply the skills and approaches of science and mathematics to the needs of their communities. A particular curriculum example is spelled out in the objectives of the Nigerian Core Curriculum in Primary Science in Box 1.

Box 1

General objectives of the Nigerian core curriculum in primary science are to help the child to:

(i) observe and explore the environment
(ii) develop basic science process skills
(iii) develop functional knowledge of science concepts and principles
(iv) explain simple natural phenomena
(v) develop a scientific attitude including curiosity, critical reflection and objectivity
(vi) apply the skills and knowledge gained through science to solving everyday problems in his environment
(vii) develop self-confidence and self-reliance through problem-solving
(viii) develop a functional awareness of and sensitivity to the orderliness and beauty of nature.

(country case study: Nigeria)

The Education of the Teachers

11. Four phases in a continuum of teacher education are noted by Thomas (Appendix II):

Phase A	Phase B	Phase C	Phase D
Pre-teaching Preparation Experience	Initial Teacher Training	Teacher Induction	In-service Training and Education

Phases of Teacher Education (Thomas, op cit)

Fig. 1

12. Phase A refers to the experience of all aspiring teachers who are likely to have had some non-formal instructional experience on which they can build during initial training. For example in Trinidad and Tobago, teachers typically teach for two to three years before gaining acceptance at the Teachers' Training College. (case study report: Trinidad and Tobago)

13. In many Commonwealth countries, Phase B primary teacher education takes place in Teacher Training Colleges. In many developing countries candidates are drawn from amongst those who have not completed upper secondary education and study in training institutions which have not attained the status of institutions of higher learning (Avalos, 1991). Many teacher training colleges continue to offer traditional curricula which provide tuition in theory of education, professional studies, teaching practice and academic study options where the latter are aimed at the personal development of the teacher rather than at classroom performance. (case study reports Zimbabwe and New Zealand)

14. Phase C is also known as the probationary period and, where it exists, is considered as part of initial training in that a certificate of qualified status is granted on its satisfactory completion.

In-service education of Teachers: INSET

15. Phase D. The central role of in-service education (INSET) in upgrading skills and updating knowledge in serving teachers is widely recognised and well documented. INSET can be tailored to specific needs, can be delivered reasonably swiftly from existing human resources and be effective in both financial and educational terms. The concept of INSET has changed in the past twenty years from orientation towards a 'training' view of imparting new information, ideas and skills to recipients, to orientation towards an interactive, 'educational' model. Many countries are trying out different forms of in-service education for both new and serving teachers and there is an ongoing need for research which investigates the particular patterns and mixes of pre- and in-service provision that are most conducive to enhancing teacher effectiveness (Dove, 1986). The lack of research is particularly noticeable at the primary level.

16. Different people have different expectations of INSET. Primary teachers may seek prescriptive, didactic answers to questions like 'How do I teach decimals?' Teacher educators may want to pass on the results of recent learning research reported in an international journal while ministries of education, in allowing funds for an INSET programme, may be looking for better results nationally in the primary leaving examination.

17. Different expectations of INSET imply different content and different styles of conducting the programme. The meeting considered the matrix reproduced in Fig. 2 below which relates different purposes of INSET to corresponding activities which can be expected to lead to their achievement.

	Component of Development Activities				
Levels of Impact	Presentation, eg: lecture	Modelling	Practice, real or simulated	Feedback & support	Assistance
General awareness	*				
Organised knowledge	*	*			
Learning new skills	*	*	*	*	
Application on the job	*	*	*	*	*

Components Required to achieve levels of impact (Bolam, 1987)

Fig. 2

The matrix should be read horizontally then vertically. For example, if 'organised knowledge' is the purpose, then it will be necessary to include modelling activities as well as simple lecture-presentation to ensure that participants stand a good chance of achieving this goal. Again, if the participants are likely to be affected to the extent that they will really 'own' the new material in a way that will change their teaching behaviour (bottom line), then they will need practice, feedback, support and on-going assistance in addition to formal presentation and modelling. The meeting agreed that the matrix is useful in emphasising the need for careful analysis of purpose and content of INSET and for different types of input, but that the matrix itself needs to be interpreted in an open way. Further rows and columns could be added, for example, to include affective changes in the participants.

18 The Meeting noted the evidence that the processes of change in education are best handled through models which work to support change where it is to

take place. For example it is reported that INSET workshops which change teachers' classroom behaviour first can be more effective in convincing teachers of the rationale for the change than a college-based lecture. (Claxton and Carr, 1992). It was further noted (case study report New Zealand) that one teacher working alone as a result of an INSET-induced change is unlikely to be able to maintain that change mutual support from a working colleague and continuing support from the system that provides the INSET. Both action research projects, in which teachers of basic science and mathematics are supported in their efforts to find and evaluate strategies for resolving classroom problems, and clinical supervision are powerful means of helping to increase teachers' understanding of the teaching-learning process, of identifying their strengths and overcoming weaknesses (Power, 1986). The argument therefore is for INSET to be school-based, taking place either wholly in school or partly in school and partly in a teachers' centre or college of education where the school situation can be modelled (Box 2).

Box 2

The LAMP (Low Attainers in Mathematics Project) was conducted from the Mathematics Centre of West Sussex Institute of Higher Education from 1984, following the publication of the Cockcroft Report. It involved 12 teacher-researchers released from their schools for one day a week to work collaboratively at the Mathematics Centre and in school. Its aims included:

- encouraging teachers to change their attitudes to the ways in which low attainers learn mathematics,
- suggesting activities which should involve low attaining pupils in a wider range of mathematics than the usual restrictive diet of 'basics',
- providing teachers with ideas and strategies which should enable pupils to change their perceptions of mathematics, encouraging them not to view the subject just as a body of knowledge to be 'passed on' as facts,
- suggesting ways in which teachers can continually gain insight into pupils' mathematics without having to rely on formal tests,
- suggesting ways in which pupils can arrive at conventional methods and terminology through their participation in problem solving activities and investigatory mathematics,
- developing ways of working which should enable pupils to see links between mathematics and other subject areas,
- suggesting ways of working which should help teachers to develop pupils' confidence and independence in handling mathematics,
- suggesting approaches which should help teachers cope with different rates of learning amongst low attainers.

(Ahmed, 1987)

19. Workshops in which teachers and teacher educators work through problems together have proved an effective vehicle for INSET. Carefully and specifically prepared, they can provide support for those lacking in confidence

and a context in which particular needs can be identified and addressed. Workshop activities that have proved fruitful include:
- exploring participants' ideas about a relevant concept, for example food or animals in science, movement in technology or fractions in mathematics,
- exploring participants' views relating to science, technology or mathematics education and appropriate teaching approaches (Box 3),
- encouraging the use of local resources, for example mathematical analysis of spirals in pineapples and other plants,
- preparation of materials (Box 4).

Box 3

The teachers were offered the following statement and asked to pinpoint any areas of disagreement:

Mathematics is effectively learned only by experimenting, questioning, reflecting, discovering, inventing and discussing. Thus, for children, mathematics should be a kind of learning which requires a minimum of factual knowledge and a great deal of experience in dealing with situations using particular kinds of thinking skills.

The teachers had to provide concrete, personal examples to back up their point of view. No second-hand stories or myths were allowed.

After some small group discussion there was a feeling that the word *only* in the statement was wrong. Many teachers gave their own schooling as examples. They said they had been taught without any experimentation in their grammar schools and yet had learned mathematics effectively.

After some probing and discussion they decided there was more to *experimenting* and *discovering* than 'scissors and paste'. They identified that this had often taken place outside class time, with friends, or on their own when experimentation and reflection were internalised.

By the end of the session many wanted the *only* underlined and everyone had benefited from the discussion.

(Ahmed, 1986 p.9)

Box 4

The Caribbean Mathematics Project (CMP)

At the Junior level (the last three years of the basic education cycle) this project operated in eight Commonwealth countries of the Eastern Caribbean. Its purpose was to raise the standard of mathematics teaching and learning at this level by raising the competence - and more importantly the confidence - of the teachers.

The CMP's strategy was in-service training through materials development. Small groups of teachers, led by a consultant, wrote draft teaching material on specific topics in the syllabus. The materials were reproduced and both the teacher-writers and other teachers tested them in their classrooms. All the project teachers came together from time to time to evaluate their experience and to modify the materials. After two or three cycles of trial and revision these were eventually published.

The CMP produced a cadre of basic level teachers whose professional competence was significantly enhanced by their involvement in the project. It demonstrated that the strategy of using materials development by teachers, in a collaborative way, can be a powerful means of in-service education.

(Wilson) (see Appendix i)

20. It is unrealistic to expect that a single-stage programme of INSET workshops could cover more than a small number of teachers. A 'cascade strategy' in which teachers who have received INSET themselves pass it on to groups of colleagues is a way of extending it. The cascade method is already in use in Commonwealth countries including Pakistan (Box 5), Malaysia, Andhra Pradesh and Bangladesh (Dove, 1986).

Box 5

One of the main components of various foreign-aided projects is the training and re-training of grass-root teachers in modern and better teaching techniques. The World Bank PEDEP Project has provided special inputs for 3-level training: A-level for master trainers at federal level, B-level for learning co-ordinators and supervisors who in turn organise C-level training of grass-root working school teachers.

(Pakistan. 11 CCEM/2/CP 7. Commonwealth Secretariat)

The advantage of the cascade model is that it can reach large numbers of teachers without the costs associated with bringing teachers to distant centres for long periods. The main disadvantage is of dilution or distortion of the message unless a continuous support and feedback system is built into the programme.

21. Cascade strategy depends on employing selected teachers (Box 6). Such teachers, while continuing their own work after receiving INSET themselves, can be given additional responsibility for INSET for other teachers in their own and perhaps other institutions. Such teachers are known as 'master teachers', 'teacher leaders', 'key teachers', 'subject co-ordinators' or 'advisory teachers'. Out of respect for the innovative work done in many countries in encouraging girls in science and mathematics education, the term 'key teacher' is used in this report instead of the obviously gendered term 'master teacher'.

Box 6

The Primary Mathematics Project (South Africa) (PMP)

The PMP is the current phase of a programme of INSET of Basic Level teachers of mathematics in several of the 'black' education systems in South Africa. Selected teachers are given an intensive one-term education programme specifically designed to equip them to teach their very traditional syllabus in a meaningful, activity-based, interactive way. On return to their schools these teachers become in-service educators of their colleagues in their own and neighbouring schools in addition to continuing their own classroom work.

A recent independent evaluation of the project rated it as highly successful. The PMP demonstrates that the 'cascade' strategy of INSET can be effective at this level, with a teaching force of limited educational background and o teaching in conditions of severe deprivation.

(Wilson) (See Appendix I)

22. The results of a cascade strategy are generally encouraging provided that certain conditions are met. These include:

a. a commitment by the key teachers to engage in INSET work after receiving their own INSET

b. mechanisms for them to be able to do so effectively; these may be provided by the Ministry of Education, by their own head of institution or through a professional association

c. the avoidance of their being over-loaded in their dual role as classroom teacher and INSET provider

d. the maintainance of ongoing support.

In developing key teachers cascade strategies for INSET, Ministries of Education will want to give careful consideration to the following questions:

a. How are key teachers to be identified?

b. What particular form of INSET is appropriate for training them and

c. Who is to conduct it?

23. The Meeting noted the invaluable role of professional associations in the professional development of teachers (Box 7) and the relative lack of professional associations for teacher educators.

Box 7

In Nigeria members of the Science Teachers' Association have been expert scrutineers in the process of adoption of the core curriculum in Integrated Science, and in the design and presentation of in-service education supporting its adoption (Bajah, 1992).

In Anglophone Cameroon, mathematics teachers organize an annual programme of in-service education which results in the raising of morale of pupils as they become aware of the improved techniques of the teachers. 'Mathematics departments in schools are often taken as models of professional organizations and involvement in improvement of teaching and learning'. (McNamara, 1992)

Non-government organisations including women's groups can also positively affect attitudes to and knowledge of basic science and mathematics in the context of children's lives both in and out of school. They remain relatively unexploited contributors to INSET (Box 8).

Box 8

NGOs include a wide range of community groups and activities. In England, in a programme of schools' industry links, adults other than teachers (AOTs) have introduced practical applications of science and mathematics into classrooms while school teachers have taken up secondments and made visits to workplaces. The organisation 'Child to Child' has actively demonstrated models of learning in which children learn from their peers. An extension of their programmes has been the recent publication of a book that links primary school mathematics with health programmes to provide an integrated learning resource (Gibbs and Mutunga, 1991). The work of the Lesotho National Council for Women in running vocational workshops for girls that include basic mathematics for commerce is representative of the notable work of many women's groups in Africa in the basic education of women and, by implication, the next generation of children. The mathematics content of traditional women's work in textiles has recently been highlighted by the British Council's touring 'Common Threads' exhibition, acting as a resource for in-service development of materials for basic level mathematics education in cross- and extra-curricular contexts both in schools and in such women's vocational programmes.
(Harris) (see Appendix I)

24. The conjunction of interactive and collaborative INSET in terms of its content and process, but for a hierarchical (cascade) model in terms of strategy, might seem incompatible until it is remembered that cascades can

include a 'feedback loop': the water that falls can circulate in a continuous process that feeds the cascade as it derives sustenance from it. In effect the school end of the cascade should work up as well as down the system. It is thus vulnerable if far removed from the political centre unless sustained efforts are made to support it and to receive experience and wisdom from it.

25. In summary, the meeting emphasised three fundamental characteristics of the style of teaching that it wished to encourage;

a: teaching must start from where the learners actually are;
b: learning must be participatory;
c: learning must be in context.

Only by a widespread move towards this kind of teaching style among teachers of science and mathematics at the basic level can standards of achievement of the mass of ordinary pupils be expected to be significantly raised. If the intention of the INSET is to forge change in teacher behaviour, then the teacher must be involved in all stages of discussion concerning the need for change and in programmes designed to facilitate it. Consequently, the strategy should:

a: start from where the teachers actually are;
b: be interactive and participatory;
c: be in context.

The basic principle is that INSET designed to encourage teachers to teach in a more open and interactive way must itself be conducted in that way; the INSET process should model the approach sought in classrooms.
The meeting repeatedly affirmed, however, that :

a: the processes of change requiring a shift in personal philosophy and attitude are extremely challenging, and
b: they need to be developed and sustained over long periods. They cannot take place without continuing support.

Problems In Teaching

26. The case study reports and the experience of their authors and the other consultants provided examples of problems in teaching and teacher education for basic level science and mathematics. In summary these problems are:

- When teaching content-based curricula, teachers frequently resist attempts to change their pedagogy towards more active involvement of pupils on the grounds that they will not be able to cover the syllabus.
- When teaching process-based curricula, teachers tend to develop their own reactionary coping strategies by separating items of content and teaching them by traditional rote methods, or by adhering closely and exclusively to the Teachers' Notes and instructional materials provided with curricula and intended as models for teachers' own examples. The result is often that curricula integrated in philosophy are dis-integrated in practice, and that practices most antagonistic to good learning and conducive to negative attitudes are perpetuated.
- In junior secondary schools, teachers qualified to teach science tend to be specialists in one or perhaps two science subjects (more likely to be biological sciences than physics or chemistry) and tend to lack exposure both to integrated science and to methods of teaching it.
- A general lack of support for primary teachers in post is noted. This lack of support includes a range of factors from lack of consultation on curriculum

change and lack of promotion prospects within the primary sector, to poor pay and conditions of service.
-There is a general and continuing lack of good, locally made teaching materials.
In summary teachers suffer from lack of training, lack of confidence and motivation, and lack of support.

Problems in Teacher Education
27. Problems summarised by the Meeting can be divided into:
i. curriculum and courses
- insufficient qualifications of student teachers on entry to initial teacher education,
- low numbers opting for science and mathematics courses,
- lack of articulation between professional and academic courses,
- lack of articulation between college and school courses,
- inadequate time spent on professional courses,
- lack of guidance on the preparation of locally based learning materials.
ii. lecturer characteristics
- inappropriate qualifications and experience for teaching integrated science courses,
- lack of primary school experience.
In general, teacher education has not kept pace with curriculum change so that the principle has not been maintained that **whatever the curriculum, teachers must be trained to deliver it.**

Improving the Education of Teachers
28. Needs for improving the education of teachers have been summarised in the Case Study report: Nigeria. To the need to update and upgrade the skills the primary teacher already has should be added the development of:
- process skills of science, laboratory skills including improvisation techniques in the preparation of audio-visual materials, etc.
- the ability to convey information in an attractive way to make science interesting and fun,
- an awareness of the 'science' in a situation thus encouraging the habit of investigation in pupils,
- knowledge and skills of continuous assessment of pupils in a stimulating and encouraging manner.

Improving the Education of Teacher Educators
29. Such a wide variety of needs identified above cannot be met solely by the traditional providers of primary teacher education, the college lecturers. The Meeting noted that two aspects of the education of teacher educators needed attention, the updating and upgrading of their own knowledge, skills and experience and a widening of the concept of teacher educator as a whole. Thomas (op cit) makes a summary of three types of primary school teacher educator in South Asia with their training needs. This has been adapted in Figure 3:

Type of Teacher Educator	Training Policy
A: graduate qualifications but little or no teaching experience	1. teaching experience 2. subject matter pedagogy materials development
B: Primary school heads or deputies with field experience but lacking status and qualfications	1. subject matter pedagogy materials development
C: Inspectors and advisors with more field experience than A but lacking experience of primary school classrooms in particular	1. classroom experience 2. upgrading and updating in all areas of teacher education as appropriate

Possible Training Needs of Teacher Educators
at different phases of teacher education.

Fig. 3

30. The changing and widening role of teacher educator at different phases of a teacher's on-going education implies that more people will be involved in more specific INSET. Responsibilities for teachers' professional education are increasingly being undertaken by cadres of specialist professionals with knowledge, skills and experience appropriate for interaction with teachers at different phases. A summary of examples of the personnel of such cadres has been adapted from Thomas (op cit) for Figure 4:

Initial Teacher Training	Induction	INSET
college-based lecturers	head teachers	inspectors
senior experienced staff	deputy head teachers	supervisors
mentors	heads of department	university faculty members
school tutors	advisors	college-based lecturers
key teachers	key teachers	key teachers
head teachers	inspectors	senior school personnel

Specialist Teacher Educators at Different Phases of Teacher Education

Fig. 4

31. A major implication of a continuum in the professional development of teacher educators is the establishment of the profession of teacher education and the structural and administrative changes within and between educational and administrative institutions to make this possible. These would require a policy of teacher educator training and professional development (Thomas, op

cit). Since it is essential that all teacher educators on the teacher education continuum should be equally valued, and particularly that primary education should be as highly valued as secondary, it would be necessary to provide the same basic salary scale and discretionary performance rewards for all career pathways. Thus, although the policy would be to capitalise more effectively on existing human resources, it might have to be conducted within different administrative structures from those currently in use. Closer links between *all* professional institutions involved in teacher education have long been argued for and attempted. For genuine parity of esteem within the profession of teacher education however, the traditional domination by the academic standards of universities still needs to be re-negotiated to include equal weighting for the professional standards of good primary school practice.

Proposals

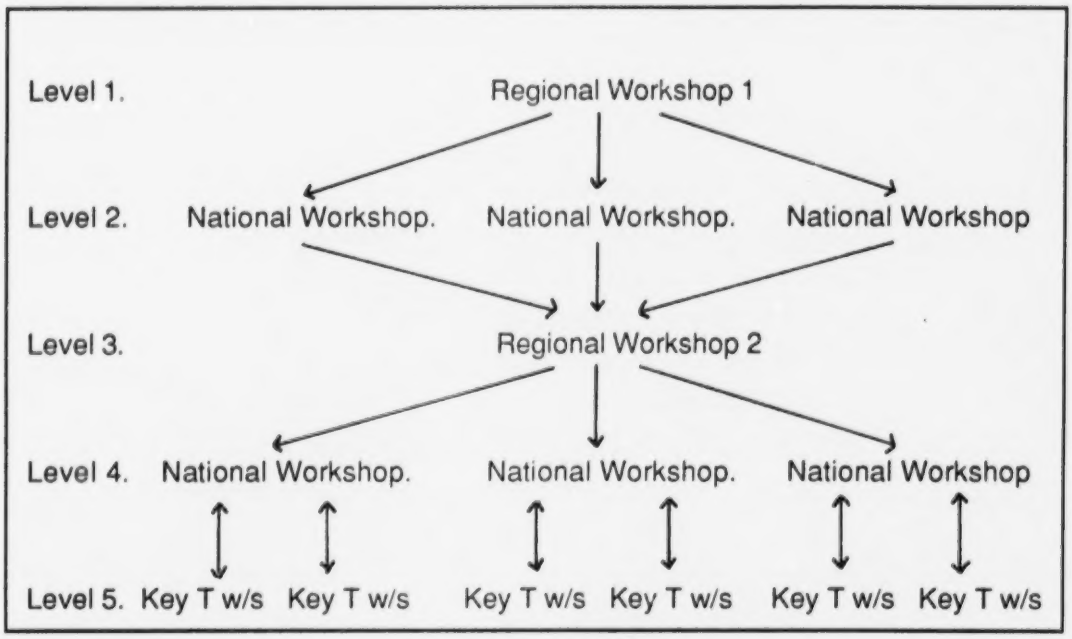
32. The meeting proposed that the educational needs of both teachers and teacher educators be addressed through overlapping programmes of INSET. Although details of the structure and content of teacher INSET in a particular country would need to be decided by the countries themselves, the meeting proposed regional collaboration in the initial stages of planning the INSET and continuing collaboration as the programme developed, so that opportunities to collect, evaluate, develop and share examples of identified innovative practice could be encouraged.

33. An INSET programme would continue to contain further academic and professional study overseas as appropriate. However, with innovation taking place in so many countries, no one country can claim overall superiority in academic and professional education. Academic interchange amongst professionals will continue to be as necessary for the advancement of knowledge as it has always been. The meeting was concerned to suggest, however, that overseas courses to which teacher educators may be seconded should themselves be checked for recent and relevant experience for their tutors and their curricula and that the development model for such courses should be the partnership rather than the relationship of expert and client.

34. Many Commonwealth countries have produced INSET science education materials for specific identified needs of teachers. The meeting proposed that a collection of such materials be made and reviewed and the results incorporated into guidelines to be drafted by the Commonwealth Secretariat for distribution. The meeting also proposed that the collection of such materials should form the start of a strategy for INSET which is described in more detail below.

A Strategy for INSET

35. The proposed strategy is in five interacting levels. As it develops, overlap between the levels also develops. The strategy is offered in diagrammatic form, in Figure 5 and details given in the Action Plan below (paragraph 36). The shortened form 'Key T w/s' means 'Key Teacher workshop'.



A Strategy for INSET

Fig. 5

36. Action Plan INSET

Stage 0 First draft and ongoing development of INSET Guidelines

Aim

To produce draft guidelines, to be improved throughout the Project, for use in workshops for teacher educator and key teacher INSET. (Suggestions for content are offered separately in Appendix III below.)

Action

1. Circulate countries asking for existing INSET materials.
2. Prepare review of results at the Commonwealth Secretariat.
3. Invite individuals or countries to write or produce draft materials on specified themes for the draft guidelines.
4. Convene a meeting of all contributors to prepare the final draft of form and content of the guidelines, at workshops as suggested below or at other times as considered appropriate.

Stage I Regional workshop on improving the quality of science and mathematics education at the basic level

Target group: Teacher educators.

Participation

1. Teacher educators from Ministries of Education; those responsible for the professional development of teachers.
2. Teacher educators from universities and colleges; those responsible for initial teacher education.
3. Teacher educators from centres and institutes; those responsible for organising and conducting in-service teacher training programmes.
4. Identified person or people responsible for draft guidelines.
5. Consultants as considered appropriate.

Preparation for the Workshop

Participants will be asked to bring materials related to:

1. Reviews of existing materials, identifying issues and needs for INSET in terms of context, learner-centred approach and nature of knowledge.
2. INSET modules related to curriculum changes especially following 'Education for All'.
3. Improving INSET with reference to methodologies, topics or areas of study, support and assistance and resources.

Objectives of the Workshop

1. To prepare a synthesis of country experiences, identifying trends and issues emerging in the region and providing additions or modifications to the draft guidelines.
2. To formulate strategies for improving science and mathematics education at the basic level through the education of teacher educators and key teachers.
3. To prepare action plans for national implementation of INSET.
4. To propose recommendations for follow-up actions.

Stage II National follow-up workshops; compilation and tryout of materials.

Objectives will have been formulated by the regional workshop. To these could be added:

1. the setting up of national committees responsible for national INSET
2. the identification of potential key teachers
3. planning appropriate programmes for Stage III.

Stage III Regional INSET workshop for teacher educators.
Materials and logistics at least partly formulated at the previous stage(s). The INSET would focus on:
1. Sharing of experience from national workshops
2. Finalising the training documents

Stage IV National INSET programme
To be conducted by those who participated in the regional INSET, leading to the setting up of national cascade models nationally negotiated.

37. Budgetary requirements for the INSET programmes suggested above would include:
1. Travel and subsistence of participants and resource persons and fees for consultants where appropriate.
2. Organisation costs for regional workshops, national implementation and workshops programme, including costs of personnel, facilities, supplies and materials, communication, transportation.
3. Publication and reporting.

38. Budget requirements for national programmes would of course be worked out on a national basis. The meeting was conscious of the implications of applying to particular funding agencies and suggested that countries might have more freedom of action if they pursued collaborative funding when preparing their proposals. With the ever changing policies of the large funding organisations it is impossible to give an accurate review but the following may be noted:
- UNESCO has no funds itself but works with groups which have. Its role is mainly information exchange.
- The British Council's resources have been cut considerably. It has the dual role of representing Britain and handling aid-related projects. The funding it handles is mainly multi-lateral, for example EEC. Its overall policy is set by the major aid donor ODA.
- ODA is currently concerned with basic education.
The meeting suggested that the Commonwealth Secretariat should prepare a document on up to date advice on sources of funding and how to apply for it.

39. Although they have no funding at their disposal, the international professional organisations in science and mathematics education are supportive of professional development,in providing a forum for the presentation and discussion of research and in maintaining professional exchanges at international level. Some have access to small supplies of money for assisting the travel expenses of fellow professionals from developing countries. Such organisations include

ICACE:	International Council for the Association of Science Education
CASTME:	Commonwealth Association of Science, Technology and Mathematics Educators
ICME:	International Congress on Mathematics Education
PME:	International Study Group on the Psychology of Mathematics Education.
IOWME:	International Organisation of Women in Mathematics Education.

40. Recommendations

The meeting recommended:

1. That policies on the education and professional development of teacher educators be reviewed with the aim of upgrading and supporting the development of the profession of teacher educator.

2. That the proposed programmes of overlapping and sustained INSET for teachers and teacher educators be set up as suggested.

3. That steps be taken to identify key personnel to take part in such INSET programmes at all levels.

4. That national committees on basic science and mathematics teaching should be established to:
- collect and review existing INSET materials
- prepare for regional and local workshops and INSET programmes.

References

(For country case studies please refer to Appendix II)
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Thomas, Elwyn. 1992. See Appendix II.

Appendix I

Names of consultants at the planning meeting.

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Dr. R.A. Hodzi	Zimbabwe	Department of Science Education University of Zimbabwe PO Box MP 167 Mount Pleasant Harare
Mrs Marianne Nganunu	Botswana	Ministry of Education P. Bag 005 Gaborone

Dr. Gilbert Onwu	Nigeria	Department of Teacher Education Science Education Unit University of Ibadan Ibadan
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Dr. Ed Jacobsen	France	UNESCO Science and Technology Education Section 7 Place de Fontenoy Paris

Commonwealth Secretariat Education Programme
Mr. Jakes Swartland
Professor Sam Bajah

Appendix II
Documents prepared for the meeting and published by the Education Programme of the Commonwealth Secretariat:

Relevant Documents

1. Framework for Discussion
2. Some Random Thoughts for Discussion
3. EDP Five-Year Plan 1991/92 - 1995/96 (STME Activities)

The Professional Development and Training of Teacher Educators and The Promotion of Teacher Quality.
Dr. Elwyn Thomas

A Synthesis Perspective of Operational, Contextual and Strategy Problems in Science and Mathematics Education.
Rogers W'O Okot-Uma

Contributed Papers

1. Mary Harris
2. Bryan Wilson
3. Dennis Chisman

Case Study Report: New Zealand.
M. Carr

Case Study Report: Nigeria.
G. Onwu

Case Study Report: Trinidad and Tobago.
June George (Mrs)

Case Study Report: Zimbabwe.
R. Hodzi

Improving the Quality of Science and Mathematics Educators at the Basic Level: The Asia and Pacific Experience.
Lucille C. Gregorio

Appendix III

Draft suggestions for the content of Guidelines.

The target is teacher educators and key teachers and the guidelines would be used both for their own development and subsequent use in INSET. Since their use and usefulness would depend to a great extent on their local relevance, it is suggested that the format and content of such guidelines should be flexible enough for local modification.

The relationship between the formats and publication of the proposed review of existing INSET materials and the proposed guidelines would be decided during Stage I of the proposed model for INSET.

The outline below is a synthesis of content drawn from the Meeting and has been summarised into five sections: Theoretical background; Practical Matters; Workshop Section possibly divided into general and country specific sections; Case Studies; Bibliography.

1. Theoretical Section
- The nature and processes of science and mathematics.
- Philosophies and theories of teaching and learning science and mathematics.
- Teaching in the cultural and environmental context.
- Research evidence for the effectiveness of activity versus traditional teaching.
- Monitoring, appraisal, assessment and evaluation.
- Systematised reflection on teaching and learning.
- Using teachers' guides.
- New technologies and their effects on society, teaching and learning.
- Statements of principle:
  starting where learners are,
  in-context learning,
  interactive learning.

2. Practical matters
- Restatement of principles with examples.
- Summary of teaching techniques with examples and summary possibly in chart or matrix form.
- Specific advice on and examples of:
  particular content,
  classroom organisation,
  cross-curriculum working.
- Materials development:
  critical use of commercial materials including calculators,
  identifying and exploiting the mathematics and science in the environment,
  locally made and found materials,
  developing content,
  design and production skills,
  language and layout,
  protection and storage,
  modifcation in use.
- Assessment and evaluation.

3. Workshop Section
- Organising INSET
- Content
- Evaluation, feedback and improving the cycle.
- Participants, resources, materials, support, funds.

4. Case Studies
- Examples of good, original, innovative and enterprising practice.

5. Bibliography
- Very carefully chosen, short selection of relevant published material with the recommendation that all selected items should be kept in resources centres, centres of teacher education, British Council libraries, etc.